

Microturbines: Activities within the Office of Distributed Energy Resources

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U.S. Department of Energy**

**Microturbine and Industrial Gas Turbine Peer Review Meeting
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Microturbines Today



- Microturbines are viable now for distributed energy applications
 - Competitive costs, performance, emissions in selected applications
 - Ideally suited to alternate fuels, CHP applications, remote siting
- Microturbines have significant expanded market potential with technology advances
 - Competitive Efficiency at < 1 MW size
 - Potential for lowest first cost
 - Lowest emissions and broadest fuel specification

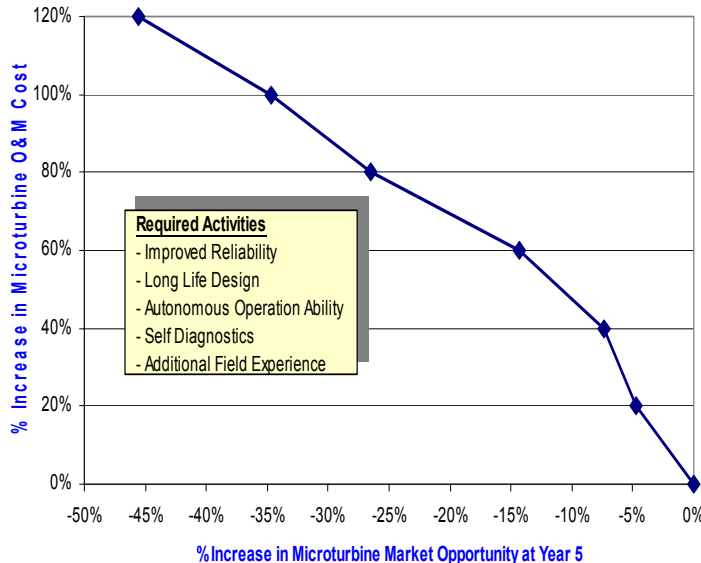
Potential for Best in Class



- Class boundaries 30 kW to 500 kW
 - Emissions potential includes < 5 ppm NO_x
 - Direct use of exhaust gas for CHP
 - Fuel flexibility
 - Potential for highest efficiency
 - Lowest manufacturing cost when fully developed (low number of moving parts)
 - Lowest installed cost potential (light weight, quiet, etc.)
- These are high reward possibilities requiring high risk investment which provide public benefits that the market place currently cannot fully value.
- Ideal opportunity for public/private partnership.

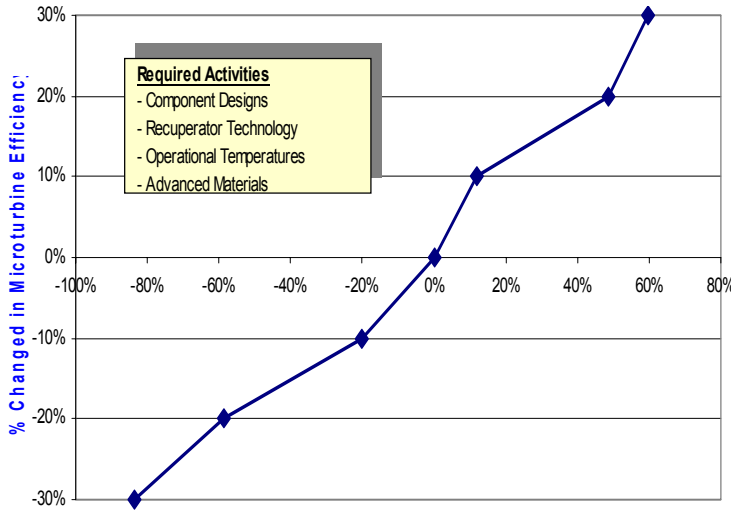
Impact of Technology on Microturbine Markets

Sensitivity Analysis on Microturbine O&M Cost



Data from proprietary market study based on customer interviews.

Sensitivity Analysis on Microturbine Efficiency



Data from proprietary market study based on customer interviews.

Non-Technical Issues That Will Affect Success of Microturbines

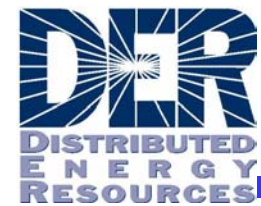


- Rate of industry deregulation
- Regulatory framework and incentives established
- Electric utility acceptance or resistance
- Financial incentives for all players in value chain
- Adequate sales and service support
- Emissions regulations
- Installation and interconnection requirements/costs
- Cost of establishing manufacturing capability

DOE DER Microturbine Activities



- **Baseline Microturbine Testing**
 - University of California-Irvine (UCI) & Southern California Edison (SCE)
 - National Rural Electric Cooperative Association (NRECA)
- **Advanced Microturbine Technology Program**
 - Program planning with Industry
 - Competitive solicitation
- **Supporting Materials Technology Projects**
- **Microturbine Integration Research, Development and Testing (funded by other DER programs)**



Baseline Microturbine Evaluation Program



- \$2.9+ Million Program begun by Southern CA Edison and University of CA-Irvine in 1996
- Funded by: SCE, DOE, CEC, EPRI, CERA, CERTS
- Project Goal:
 - Determine the availability, operability, reliability and performance characteristics of commercially available microturbines
- Project Objectives
 - Compare manufacturer claims to actual experiences from installation, operation and testing of units
 - Assess microturbine performance against SCAQMD emissions rule and IEEE power quality standards

Microturbine Field Tests at U.S. Rural Electric Cooperatives



- Project Partners: National Rural Electric Cooperative Assn. (NRECA) Central Research Network (CRN), ORNL, EPRI
- Conduct nationwide field tests of microturbines from several different manufacturers
- Collect application and operation data on microturbine installation and performance
- Assess microturbine feasibility and reliability in diverse applications and environments
- Benchmark future improvements in microturbine performance, operation, and maintenance

Industry/DOE Collaborated to Establish Advanced Microturbine Goals



- Modeled after National Academy of Science (NAS) recognized DOE Advanced Turbine System (ATS) program
- Goals set in DOE/Industry Workshop (Nov 1998) and Program Plans (Dec 1999)
 - 6 cost-shared awards in July 2000
- Goals for superior 2007 microturbine product
 - High electrical efficiency \Rightarrow 40%
 - Low environmental impact \Rightarrow $\text{NO}_x < 7$ ppm
 - Durable and affordable \Rightarrow 11,000hr MTBO & $< \$500/\text{kW}$
 - Fuel flexible \Rightarrow Natural gas, biofuels, propane, waste fuels & diesel

Advanced Microturbine Program



- Six year program (FY 2000 - 2006), \$60+ million Govt. investment
- Program to include:
 - Competitive solicitation(s) for engine conceptual design, development, and demonstration; component, sub-sub-system development
 - Competitive solicitation(s) for technology base in areas such as materials, combustion, sensors and controls, etc
 - Technology evaluations and demonstrations
- End-use applications open to include stationary power applications in industrial, commercial, and institutional sectors



Microturbine Program RD&D Plan Funding

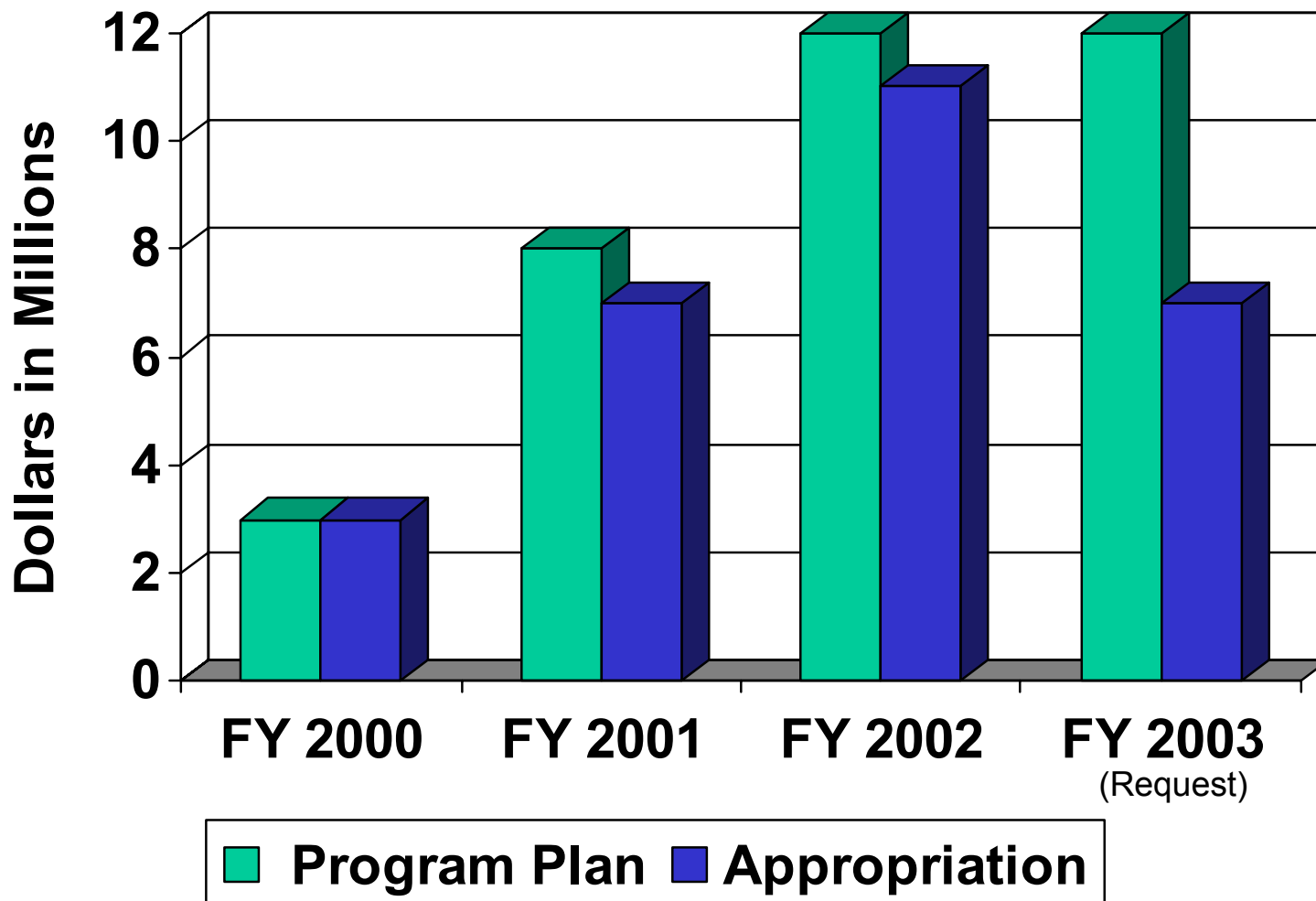


From the Advanced Microturbine Systems Program Plan 2000-2006



(\$M)	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	Total
Concept Development	1.5	1.5	1.0	0.5	0.5	--	--	5.0
Components, subsystems, and integration	1.0	5.5	10.0	9.0	9.0	8.0	2.0	44.5
Demonstrations	0.5	1.0	1.0	2.5	2.5	3.0	3.0	13.5
Total	3.0	8.0	12.0	12.0	12.0	11.0	5.0	63.0

Advanced Microturbine Program Funding



Advanced Microturbine Solicitation



- Solicitation for up to 5 year projects - \$10,000,000 Govt share max
- Proposers could propose on one or more tasks - start at any point
 - Task 1 - Concept research and development, component development and testing
 - Task 2 - Subsystem component design and development
 - Task 3 - Microturbine modification for integration of advanced technologies
 - Task 4 - Microturbine system assembly and testing
 - Task 5 - Pre-commercial demonstration (up to 8,000 hours)
- Industry cost share:
 - 30% Tasks 1 & 2
 - 45% Tasks 3 & 4
 - 60% Task 5

Solicitation Technical Evaluation Criteria



- **Description of Proposed Microturbine System (50 points)**
- **Research, Development and Test (RD&T) Plan (20 points)**
- **Teams Capabilities, Personnel, and Facilities (30 Points)**
 - Applicants expected to utilize a variety of team such as **microturbine manufacturer** (one or more required), suppliers and vendors, Universities, Research organizations, National Laboratories, End users

Advanced Microturbine Projects



2000

- ▶ 17-30% Efficiency (LHV*)
- ▶ Double digit ppm NO_x

FY00 – 6 Awards

- ▶ Ingersoll-Rand
- ▶ UTC
- ▶ GE
- ▶ Honeywell
- ▶ Capstone
- ▶ Solar



Average cost share for total
program ~ 50%, staged over
development – 30, 45, 60%

2007

- ▶ 40% Efficiency (LHV*)
- ▶ Single digit ppm NO_x

* Lower Heating Value

Advanced Materials for Microturbines

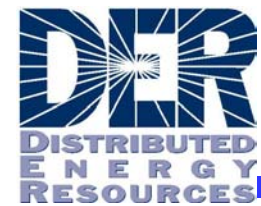


- Advanced materials are a key enabling technology for advanced microturbines:
 - Monolithic ceramics: hot section components, combustor liners
 - Ceramic composites: combustor liners
 - High temperature metal foils: recuperators
 - High conductivity carbon foam: power electronics
- A materials program to support microturbines is underway and managed by ORNL
 - Program designed to meet needs of advanced microturbine developers to develop materials technology base
 - “Peer Review” held June 2001

Examples of Program Coordination



- **External Coordination**
 - States (CEC, NYSERDA)
 - CEC EPAG solicitation
 - NYSERDA solicitations
 - EPRI
 - Natural Resources Canada (CANMET)
- **Internal DOE**
 - Industrial Gas Turbines (materials and low emissions)
 - Integrated Energy Systems (DER)
 - CHP (DER)
 - Interconnection (DER)
 - Industrial Distributed Generation (DER)
 - Energy Storage (DER)
 - Micro-Grid/Integration (DER/CERTS)
 - Fuel cell hybrid systems (FE)
 - Federal sites (FEMP)



DOE/Industry Microturbine Partnership



- Capturing 30 kW to 500 kW microturbine attributes: Low emissions, high efficiency, fuel flexibility, lowest manufacturing cost potential and lowest installed cost potential
- Achieving goals great public benefit
 - Reduces transmission line demand in distributed generation applications, particularly in non-attainment areas
 - Expands customer choice for meeting power/heating/cooling (CHP), reliability, and security needs
 - Expands US market fit, reducing customer cost through competition with current options
 - Reduces NOx emissions
 - Reduces greenhouse gas emissions and conserves natural resources by converting >70% fuel energy with CHP
 - A critical element as we transition toward a hydrogen economy.

For Additional Information



The screenshot shows the DER website interface. At the top, it says "Energy Efficiency and Renewable Energy Network (EREN)" and "U.S. Department of Energy". Below this is a banner with the DER logo and the text "DISTRIBUTED ENERGY RESOURCES" and "The Power of Choice". A search bar is present. On the left, there is a sidebar with links: "About the DER Office", "DER Basics", "DER Technologies in Action", "Project Financing & Partnering", "Regulatory & Policy Issues", and "State & Local Information". The main content area has two paragraphs. The first paragraph discusses the strain on the electricity delivery system due to escalating demand for power, electricity shortages, power quality problems, rolling blackouts, and electricity price spikes. The second paragraph mentions the need for high-quality, reliable electricity and how DER offers a faster, less expensive alternative to traditional power plants and transmission lines. On the right, there is a "News & Events" section with a link to a press release about a new clean energy technology park and a link to a DOE DER conference.

Energy Efficiency and Renewable Energy Network (EREN) ☐ U.S. Department of Energy

DER DISTRIBUTED ENERGY RESOURCES

DER Programs Documents & Resources Site Map Search DER

About the DER Office
DER Basics
DER Technologies in Action
Project Financing & Partnering
Regulatory & Policy Issues
State & Local Information

The nation's electricity delivery system is straining in the face of [escalating demand for power](#). Electricity shortages, [power quality problems](#), rolling blackouts, and electricity price spikes are endemic.

To meet the country's need for high-quality, reliable electricity, [distributed energy resources](#) (DER) offer a faster, less expensive alternative to the construction of large, central power plants and high-voltage transmission lines.

The U.S. Department of Energy's Office of Distributed Energy Resources is working with industry stakeholders to streamline the integration of distributed energy systems with the electricity grid.

News & Events
New York to develop 280-acre clean energy technology park ([8/20/01 press release](#)).
[DOE DER conference](#) and peer review (Nov. 28-30) brings DER players together in Washington.
[Upcoming Events](#)
[Weekly Summary of Events](#)

www.eren.doe.gov/der

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